CEBAF EXPERIMENT 93-009

The Polarized Structure Function G_{1n} and the Q^2 dependence of the Gerasimov-Drell-Hearn Sum Rule for the Neutron

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Polarized structure functions of the nucleon are of great interest both at high and at low Q^2, since for both extremes rigorous sum rules have been formulated. The Ellis-Jaffe sum rule and the Björken sum rule for deep inelastic polarized lepton scattering at high Q^2 have been recently tested by several experiments, yielding some discrepancy between experimental results and a priori expectations. Part of this discrepancy might be explained by the Q^2 - dependence of the deep inelastic sum rules. Several models for this Q^2 - dependence have been proposed. These models are constrained by the requirement that the deep inelastic sum rules have to approach the value given by the Gerasimov-Drell-Hearn (GDH) sum rule as Q^2 goes to 0, times a factor of $Q^2/(16\pi^2\alpha)$.

On the other hand, only indirect evidence exists on the validity of the GDH sum rule at $Q^2 = 0$ (real photons). An analysis of photon pion-production data indicates a considerable deviation from the prediction of that sum rule, especially for the difference between proton and neutron. This deviation could be due to contributions to the GDH integral from high energy transfer ν, which are not included in the pion-production analysis. Indeed, a naive extrapolation of the deep inelastic data above the resonance region down to $Q^2 = 0$ combined with a model of the resonance contribution to the GDH sum rule yields a better agreement with the prediction.

To test the ideas outlined above, it is very important to study the Q^2 - evolution of these sum rules both near the photon point ($Q^2 = 0$) and over a wide range of Q^2, placing special emphasis on the region of high energy transfer. On the other hand, it is also very interesting to study polarization variables for inelastic electron scattering in the resonance region to constrain models of resonance structure and transition amplitudes. For both purposes, one has to study both the proton and the neutron, which will yield largely independent data.

Experiment 93-009 in Hall B is an extension of experiment 91-023 (polarized structure functions of the proton). It will study the Q^2-dependence of the GDH sum rule for the neutron. We will use the same high field (5T) cryogenic (1K) target as 91-023, but with ND_3 instead of NH_3 as the polarized target material. Subtraction of the proton contribution from the deuteron data yields the neutron asymmetry. We expect a beam polarization of 75% and a target polarization of 40%. We will measure 40 days at 1-5 nA beam intensity and 0.8-4 GeV beam energy. Inelastically scattered electrons will be detected by the full set of detectors in the CLAS, which will be run at reduced and reversed field to extend the coverage of small Q^2. We expect significant data on the polarized structure functions and the GDH sum rule for momentum transfers from $Q^2 = 0.15$ to $Q^2 = 2.0$ GeV^2/c^2 and for energy transfers from threshold to nearly beam energy.

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A Proposal for an Experiment using the CEBAF Large Acceptance Spectrometer

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